Changes in Chela Heights and Carapace Lengths in Mature Male Red King Crabs *Paralithodes camtschaticus* After Molting in the Laboratory

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ABSTRACT: Measurements from 64 mature male red king crabs *Paralithodes camtschaticus* were made in carapace length (CL) and chela height (CH) before and after they molted in the laboratory. Increases in chela height for adult males 72–143 mm CL averaged 3.2 mm (SD = 1.5) at molting, but claw growth was not correlated to initial CH. At all carapace lengths examined there were individuals with both relatively large and small CH/CL ratios. After molting, CH/CL ratios increased in 28%, decreased in 25%, and stayed the same in the remaining 47% of the males. Among mature males, large or small claws relative to CL seemed to be an individual trait that was retained through the molt.

INTRODUCTION

The red king crab *Paralithodes camtschaticus* is an important commercial species in Alaska. There is considerable interest in understanding its growth and maturity processes so stocks can be managed for sustained yield. One goal of the management program is to protect newly matured males from the fishery to allow them a chance to breed (Donaldson and Donaldson 1992). A change in the ratio of chela height (CH) to carapace length (CL) is one method used to determine male maturity status (Somerton 1980). There is a large body of information on carapace growth, but there is no corresponding information on chela growth for red king crab. The objective of this study was to provide data on carapace and chela allometry of individual males known to be mature and to test for changes in CH/CL ratios after molting. This information was needed to examine some of the assumptions of previous investigators who have used chela and carapace measurements to estimate maturity.

METHODS

Male red king crabs were captured near the Alaskan cities of Juneau, Kodiak, and Homer and held in large seawater tanks at the Seward Marine Center Laboratory. Growth observations were made over several years in conjunction with another study (Paul and Paul 1990). No records were kept on the geographic origin of the 64 males that successfully fertilized 1 or more mates and then molted in the laboratory. For each crab, premolt and postmolt CL and CH were recorded to the nearest millimeter. CL was measured from the eye notch directly to the posterior edge of the carapace. CH was measured across the widest portion of the largest claw. During the study water temperatures ranged from 3° to 11°C and salinity was 32–34 ppt. Crabs were fed a variety of foods, whole Pacific herring *Clupea pallasi* and octopus *Octopus dofleini* being the most common.

RESULTS

Figure 1 shows a linear relationship between premolt CL and CH for the 64 males ($df = 62, P < 0.0001$). Molting occurred in 20% of the males during December, 48% in January, and 11% in March; a few males molted during each of the remaining months of the year. The average increase in CL was 10 mm (SD = 3.5 mm). Depending on the individual, CL changed by -1 to 19 mm after molting (Figure 2). Growth in CL could not be correlated to initial CL (Figure 2). Chela growth followed a similar ambiguous pattern

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(Figure 3) and averaged 3 mm (SD = 1.5). CH values changed from 0 to 7 mm depending on the individual. There was a linear relationship between initial CH and postmolt CH ($df = 62$, $P < 0.0001$; Figure 4).

At all carapace lengths there were individuals with both relatively large and small CH/CL ratios. After molting CH/CL ratios increased in 28%, decreased in 25%, and stayed the same in the remaining 47% of the

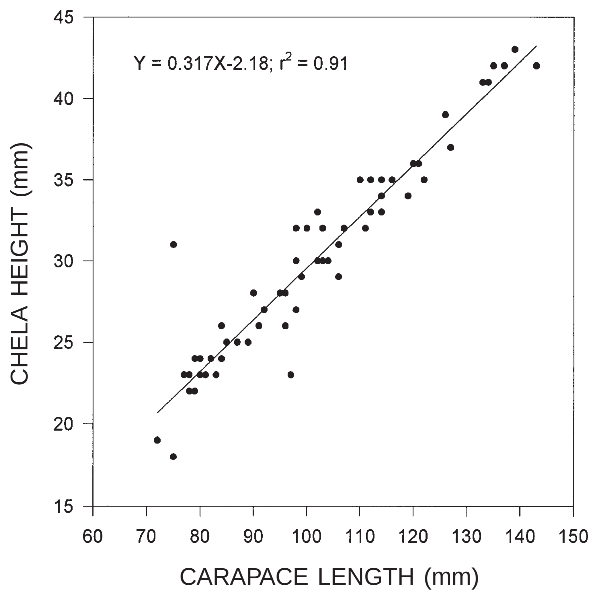

Figure 1. Carapace length and chela height for mature male red king crab before molting in the laboratory.

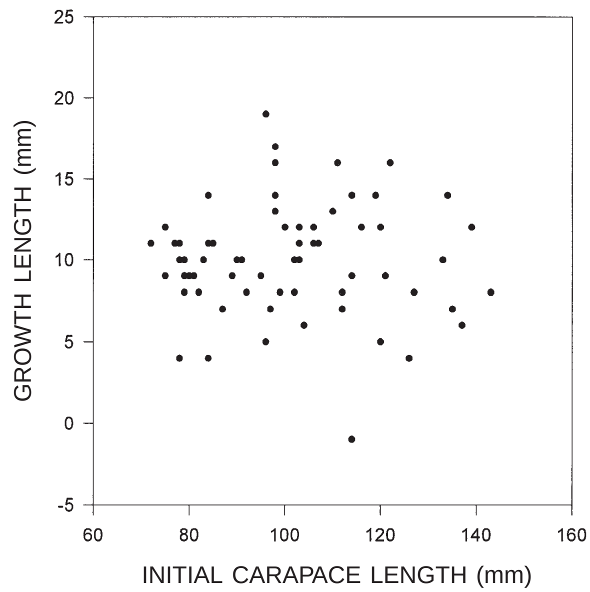

Figure 2. Changes in carapace length for mature male red king crab after molting in the laboratory.

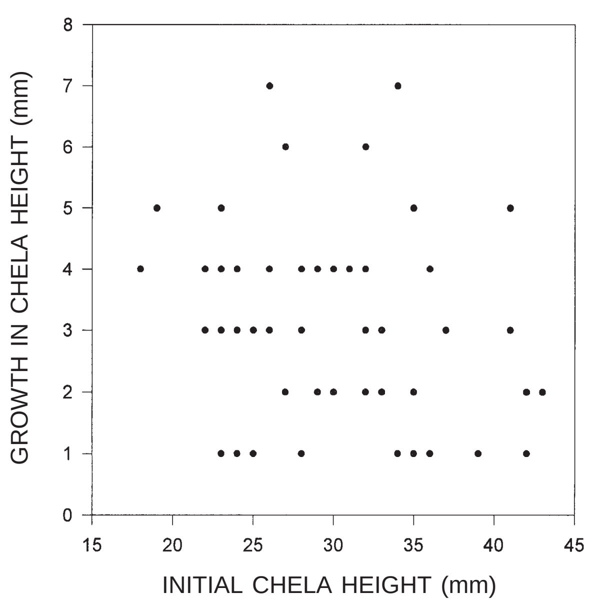

Figure 3. Changes in chela height for mature male red king crab after molting in the laboratory.

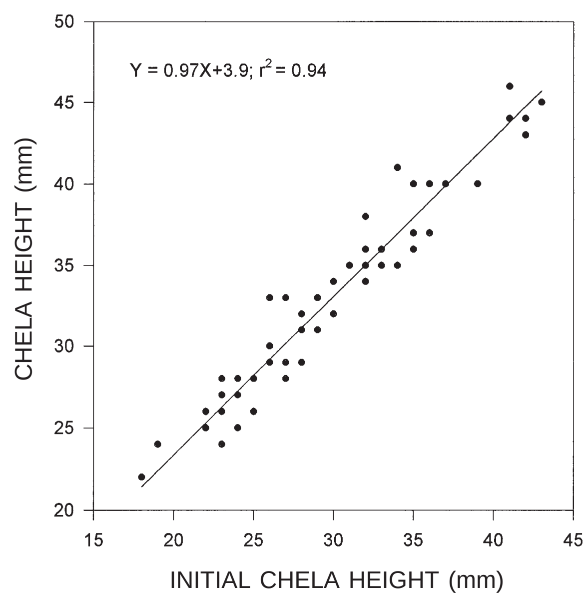

Figure 4. The relationship between initial chela height and postmolt chela height for mature male red king crab after molting in the laboratory.

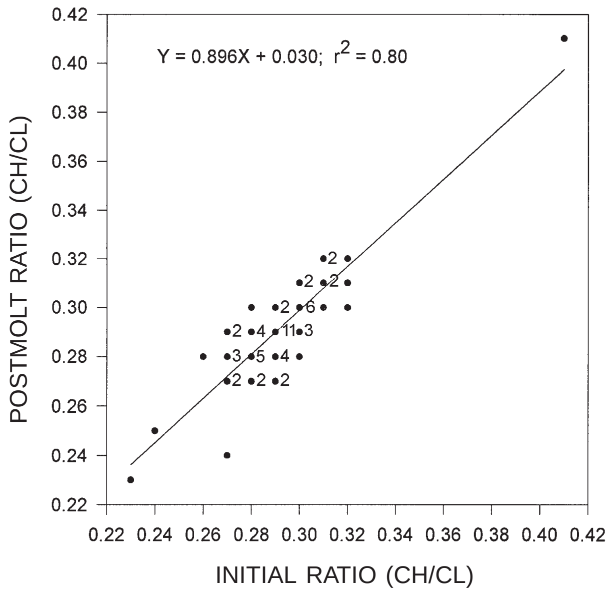

Figure 5. Change in the ratio of chela height relative to carapace length (CH/CL) in mature red male king crab after molting in the laboratory. There are 64 measurements. Numbers to the right of plotted values indicate the number of data points sharing identical coordinates.

cases. The mean premolt CH/CL ratio for the 64 males was 0.29 (SD = 0.02), and the postmolt ratios had identical values for the mean and standard deviation. A Mann-Whitney Rank Sum test indicated there was no significant difference ($P = 0.986$) between premolt and postmolt CH/CL ratios. The premolt and postmolt CH/CL ratio data exhibited a linear relationship ($df = 62$, $P < 0.0001$; Figure 5). Among mature males, large or small claws relative to CL seemed to be an individual trait retained through the molt. Table 1 provides individual premolt and postmolt morphometrics.

DISCUSSION

Growth models for adult red king crab CL have been developed by several authors and their results are reviewed in Jewett and Onuf (1988). Earlier observations of CL growth of 10 to 20 mm for large males (Jewett and Onuf 1988) are similar to those noted in this laboratory study (mean = 10 mm), although there were many individuals that grew only 4–6 mm. One adult male (114 mm CL) was actually 1 mm smaller after the molt. Because our specimens came from 3 geographical locations and did not include small or immature individuals, it would be inappropriate to make a more detailed comparison of our observed changes in CL to those noted in other reports.

Table 1. Changes in carapace length (CL) and chela height (CH) in 64 mature Gulf of Alaska male red king crabs after molting in the laboratory.

Old CL (mm)	New CL (mm)	Old CH (mm)	New CH (mm)
72	83	19	24
75	84	31	35
75	87	18	22
77	88	23	26
78	88	23	26
78	89	22	26
78	89	23	28
79	87	22	25
79	88	22	25
79	89	24	27
80	89	24	28
80	89	23	27
81	90	23	26
82	90	24	25
83	93	23	26
84	88	24	25
84	95	24	27
84	98	26	29
85	96	25	28
87	94	25	26
89	98	25	28
90	100	28	32
91	101	26	30
92	100	27	29
95	104	28	31
96	101	28	29
96	115	26	33
97	104	23	24
98	111	32	34
98	112	27	33
98	114	27	28
98	115	30	34
99	107	29	31
100	112	32	35
102	110	30	32
102	112	33	36
103	113	30	32
103	114	32	36
103	115	30	32
104	110	30	32
106	117	31	35
106	118	29	33
107	118	32	35
110	123	35	40
111	127	32	38
112	119	35	36
112	120	33	35
114	128	35	40
116	128	35	37
119	133	34	41
120	125	36	37
120	132	36	40
121	130	36	40
122	138	35	40
126	130	39	40
127	135	37	40
133	143	41	44
134	148	41	46
135	142	42	44
137	143	42	43
139	151	43	45
143	151	42	44

No previous observations on chela growth were found for comparison of growth increments. Because our specimens were males collected in 3 separate areas of the Gulf of Alaska, some intrinsic geographically based differences in CH growth patterns may exist that were not apparent. Thus, the growth information in this report should not be viewed as being representative of specimens from a specific geographical area; rather, the usefulness of the data is to identify the magnitude of changes in chela allometry that can occur in individuals. Future efforts must be made to compare CH changes from the different stocks of red king crab to examine geographical growth trends.

The relationship between CH and CL measurements has been used to estimate maturity status in king crabs (Somerton 1980; Somerton and MacIntosh 1983). Somerton (1980) created a computer program called MATURE that identified a change in slope of the relationship between these parameters, and he applied it to CL and CH measurements of Bering Sea red king crab males 60–190 mm CL. That exercise was done without the benefit of any data on how CH changes during growth. Clearly, when maturity is reached, the CH/CL ratio does not necessarily continue to increase with molting. In mature males the CH/CL ratio can even decrease with molting. It remains to be seen if immature, or maturing, male red king crabs exhibit this same mode of growth, but if they do, the technique of using CL and CH measurements to identify maturity status may not be a simple process.

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